

REMARKS

Claims 1-5 and 7-18 now stand in the application, claim 6 having been canceled and its limitations incorporated into claim 1. Reconsideration of the application and allowance of all claims are respectfully requested.

Regarding the claim to priority, it is noted that the application was filed February 10, 2004, as acknowledged by early filing receipts from the U.S. Patent and Trademark Office. The filing date was apparently erroneously changed when an executed declaration was subsequently filed. A request for correction of the filing receipt is being concurrently filed.

As to the certified copy of the priority document, this was also filed on July 7, 2004, at the same time as the executed declaration. The Image File Wrapper of the present application shows the priority document submission letter. It also shows an "Artifact sheet indicating an item has been filed which cannot be scanned." Examination of this "artifact sheet" shows that the unscannable item is referred to as "FRPR", indicating a French Priority Document. So it appears that the certified copy of the priority document is indeed in the USPTO file, but has simply not been scanned. The undersigned requests that the USPTO file be checked, and if the certified copy still cannot be found, a replacement copy will be obtained.

The Title and Abstract have been amended as requested by the examiner.

The enablement rejection stated in paragraph 10 of the Office action is respectfully traversed. The critical aspect of the binder according to the present invention is that it is a styrene-acrylate copolymer which is a combination of elementary styrene units ($-\text{CH}_2\text{CHC}_6\text{H}_5-$), and of elementary acrylic ester or acrylate units ($-\text{CH}_2\text{CHCOOR}-$). This is stated in paragraph

[09] of the specification. The language used in the original claim was meant to be an alternative way of expressing this characteristic of the binder, but this language in the claim has now been replaced with the simpler and (hopefully) clearer recitation. Styrene-acrylate copolymers are known, and one of ordinary skill in the art would be easily able to make and use the invention.

The rejection under the second paragraph of 35 USC 112 is believed rendered moot by the amendment made to claim 1 wherein the variables p, q and x are no longer recited in the claim.

The prior art rejections are respectfully traversed.

The present invention relates to a secondary electrochemical cell with an alkaline electrolyte, the cell containing a non-sintered electrode comprising a two-dimensional conductive support covered in a layer containing an electrochemically active material and a binder, wherein said electrochemically active material contains a nickel hydroxide, and the binder is a mixture of a cellulose compound and a styrene-acrylate copolymer.

Non-sintered electrodes having a three-dimensional conductive support such as felt or foam are known in the art, as described at lines 16-20 of page 1 of the specification. For reasons of cost, there is now a move towards the use of two-dimensional conductive supports. However, the known binders used to produce an electrode with a three-dimensional support prove unsuitable for a two-dimensional support, as described at lines 20-23 of page 2 of the specification.

Further, binders for positive electrodes tend to degrade because they are exposed to the high potential of the positive electrode. Degradation of the binder does not occur at the negative electrode which operates at a lower potential than the positive electrode. Thus, there is a need for

a binder which is suitable for a two-dimensional support and which withstands degradation caused by the exposition to a high potential.

The invention provides a specific binder for a secondary electrochemical cell comprising a non-sintered electrode comprising a two-dimensional conductive support. The electrode has a mechanical behaviour and a mass capacity which are at least equivalent to those of an electrode having a three-dimensional current-collecting support, as discussed at lines 3-6 of page 2.

In each of his prior art rejections, the primary reference relied on by the examiner is Kawano. Kawano discloses a non-sintered type nickel electrode comprising a metal plate or a metal foil, which is worked or formed into a corrugated shape (col.2, lines 43-47). The nickel electrode can be made by first preparing a paste comprising nickel hydroxide powder mixed with an aqueous solution of carboxymethylcellulose and styrene-butadiene rubber (col.4, line 49). The resulting paste is then coated on the sides of each of the metal plates.

The Examiner characterizes Kawano as disclosing a two-dimensional substrate, but it is respectfully submitted that the examiner has misread Kawano. Kawano's electrode has been corrugated such that it exhibits an apparent thickness which is not less than 3 times larger than the metal plate (col.2, lines 47-50). Figures 2A, 2B and 3 show the cross-sectional view of the electrode. These figures show that the section of the electrode looks like a succession of "crests" and "bottoms". The "crest" regions and the "bottom" regions result from upward and downward deformations of the metal, plate respectively. See also claim 1 of Kawano.

In addition to the presence of crest and bottom regions, slitted portions (looking like teeth in Figures 2A, 2B and 3) have been formed on the surface of the metal plate such that a three-

dimensional configuration is formed (col.3, line 61). The fact that Kawano's electrode is a three dimensional electrode is also explicitly disclosed at column 6, lines 42 and 46 and in claim 1.

The three dimensional configuration, created by corrugating the metal plate, combined with the presence of a microscopically-irregular layer on each surface of the metal plate is responsible for a high bonding force between the active material and the substrate (metal plate).

“In the non-sintered type nickel electrode of the invention, the electrode substrate is formed into a corrugated shape, and the microscopically-irregular layer is formed on each of opposite surfaces thereof. With this construction, the force of bonding between the substrate and an active material is increased. As a result, even when the charging and discharging are repeated over a long period of time, the active material is hardly separated from the electrode substrate, thereby prolonging a lifetime of the cell.”(col.2 1.58-67).

Kawano does not disclose a two dimensional conductive support, or a binder which is a mixture of a cellulose and a styrene-acrylate copolymer.

The problem underlying the instant invention is to find a two-dimensional electrode the mechanical behaviour and the mass capacity of which are at least equivalent to those of an electrode having a three-dimensional current-collecting support (p.2, lines 3-6 of the application). The skilled person would not consider Kawano, because Kawano's current-collecting support is three-dimensional.

If the skilled person had considered Kawano, he would not have been taught the solution of the invention. Indeed, Kawano solves the problem of improving the bonding force between the substrate and the active material by preparing a three dimensional electrode and not by selecting a particular binder.

In contrast, the invention is based on the discovery that the selection of a binder which is a mixture of a cellulose compound and a styrene-acrylate copolymer improves the bonding force

between the substrate and the active material and improves the mechanical behaviour of the electrode (p.10, line 16).

The skilled person, facing the problem of providing an electrode, the mechanical behaviour and the mass capacity of which are at least equivalent to those of an electrode having a three-dimensional current-collecting support (p.2, lines 3-6 of the application), would increase the electrode thickness rather than selecting a specific binder. Indeed, Table 1 of Kawano indicates that the higher the apparent thickness the longer the lifetime of the cell. An analysis of Examples A-2, B-2, C-2 and D-2 shows that an apparent thickness of 150, 180, 300 and 600 μm , corresponds to utilization factors at 3rd cycle of 81.7, 94.0, 95.2 and 96.3 % respectively. The same conclusion can also be drawn from Examples A-3, B-3, C-3 and D-3.

As to the secondary references, the German '107 reference teaches a secondary electrochemical cell with an alkaline electrolyte (p.2, line 6), the cell containing a non-sintered electrode ("Pasten-type" p.2, line 10) comprising a two-dimensional conductive support ("ein perforiertes Metall" p.2 l.11) covered in a layer containing an electrochemically active material (p.2, line 10) and a binder ("Bindemittel" p.2, line 14), wherein the electrochemically active material contains a nickel hydroxide (positive electrode of the nickel-metal hydride battery), and the binder is a mixture of a cellulose compound (CMC p.8, line 43) and acrylate (p.2, line 47).

The German '107 reference discloses the generic term of acrylate. A generic disclosure does not preclude novelty in the use of a specific example falling within the terms of the generic disclosure. Thus, the German '107 reference does not disclose a mixture of a cellulose and a styrene-acrylate copolymer.

The German '107 reference suggests replacing a fraction of CMC by an acrylate as demonstrated by examples 7-9 vs. comparative examples 1-6. The skilled person considering this reference would be taught to replace the styrene-butadiene rubber of Kawano by an acrylate, but not by a styrene-acrylate copolymer. He would not be taught to replace the butadiene units of the styrene butadiene rubber disclosed in Kawano by acrylate units.

Further, the German '107 reference clearly focuses on the negative electrode. Indeed, the general description and example 1 of this reference both describe the use of the binder in the negative electrode (p.2, lines 33, 37, 66 and 67). Example 1 gives practical indications for the preparation of a negative electrode containing acrylate. The German '107 reference does not give any information with respect to the composition of a binder for the positive electrode. The skilled person considering this reference would be taught to use acrylate in the negative electrode rather than in the positive.

Further, the German '107 reference does not suggest that a mixture of a cellulose compound and acrylate is resistant against oxidation because of the high potential of the positive electrode.

Thus, the combination of Kawano and the German '107 reference suggests the skilled person to use a binder containing acrylate in the negative electrode. The combination of Kawano and the German '107 reference does not suggest to use a copolymer of styrene-acrylate in the binder of the positive electrode.

Bernard discloses a secondary electrochemical cell with an alkaline electrolyte, comprising :a negative electrode comprising an hydridable alloy whose surface is covered by a protective layer constituted by nickel hydroxide [0009], and a positive electrode.

Paragraph [0013] of Bernard teaches that the negative electrode comprises: a conductive support which can be either a two-dimensional or a three-dimensional support, and a binder which is preferably selected from a styrene and butadiene copolymer and a styrene and acrylate copolymer.

First, paragraph [0013] does not suggest the specific combination of a two-dimensional support with a binder containing a styrene-acrylate copolymer.

Second, paragraph [0013] of Bernard teaches a negative electrode, not a positive electrode.

An example of a negative electrode is given in Example 8. This electrode comprises: a conductive support which is a nickel foam [0049], thus a three-dimensional support, a thickener made of hydroxypropylmethylcellulose (HPMC) [0048], and a binder made of styrene/butadiene rubber [0048].

Thus, Example 8 of Bernard does not suggest the combination of a two-dimensional support with a styrene-acrylate copolymer.

The positive electrode disclosed in Bernard may be of the sintered type or it may include a foam support [0014]. With respect to alternative 1), a sintered type electrode is opposed to a non-sintered type electrode. As explained above and at page 1, line 1 of the application, the invention is limited to a non-sintered electrode. With respect to alternative 2), a foam support is a three-dimensional conductive support (p.1, line 19). Instead, the conductive support in claim 1 is a two-dimensional conductive support.

Further, the experimental section of Bernard discloses that the positive electrodes are prepared using nickel foam as a conductive support, thus a three-dimensional support.

“The conductive support of the positive electrode acting as a current collector was a nickel foam.” [0050]

Bernard suggests a positive electrode having a three dimensional support.

Thus, Bernard does not suggest the combination of : an electrode comprising a two-dimensional support with a mixture of a cellulose and a styrene-acrylate copolymer.

Further, it does not suggest this specific combination in relation with a positive electrode.

As to Vandayburg, that reference discloses a secondary electrochemical cell containing: a positive electrode; a negative electrode, and an electrolyte which can be either an aqueous or non-aqueous electrolyte (col.6, lines 20-21); at least one of the positive electrode and the negative electrode includes an electrode mixture containing an active electrode material and a binder, wherein the binder contains polyacrylamide and at least one copolymer selected from the group consisting of carboxylated styrene-butadiene copolymer and styrene-acrylate copolymer.
(claim 1)

Vandayburg discloses a current collector which may be a thin metal foil, thus a two-dimensional current collector (col.5, line 55). Although Vandayburg discloses that it is possible to use its binder in an aqueous electrolyte (col.6, lines 20-21), its teaching clearly focuses on non-aqueous electrolytes, and especially lithium-ion batteries. Indeed, see:

- title “*Latex binder for non-aqueous battery electrolytes*”
- “*The present invention is the result of extensive investigation of various binder combinations for an aqueous based electrode mixture used for making electrodes for rechargeable lithium ion batteries.*” (col.3 l.10-13)
- “*The objective of the investigation was to discover water-soluble binders that eliminate the need for organic solvents in the preparation of electrodes for batteries having a non-aqueous electrolyte” (col.3 l.13-16)*

In contrast, the cell of claim 1 contains an alkaline aqueous electrolyte.

Examples of some positive electrode materials disclosed in Vandayburg include LiCoO_2 , LiMn_2O_4 and LiNiO_2 for rechargeable lithium cells.

Examples of useful positive electrode materials for primary lithium metal cells include FeS_2 , TiS_2 , V_2O_5 and MnO_2 (Col.5, lines 18-32). Col.7, lines 37-40 focuses on a positive electrode for primary Li/FeS_2 cells.

Vandayburg suggests a binder suitable for a positive electrode contained in a lithium cell but not for a positive electrode comprising nickel hydroxide as specified in claim 1.

The binder disclosed in Vandayburg necessarily contains polyacrylamide because it improves the smoothness and uniformity of the electrode mixture.

“Polyacrylamide is a linear water-soluble polymer which is believed to improve the smoothness and uniformity of the mix, thereby positively affecting the rheological properties of the mix and the evenness of the mix coating”.(col.3 1.42-46)

The skilled person would not consider a document describing the use of polyacrylamide in the binder as it was known by the person skilled in the art at the time the invention was made that polyamide decomposes in presence of a strong alkaline electrolyte. The decomposition releases nitrogen compounds which are responsible for a high self-discharge of the cell.

Applicant provides herewith an article from the Journal of Power Sources 2004, 137(2), 317-321. This article explains at page 2, left column, lines 85-89 that “it was found in earlier studies that polyamide separators decompose in a remarkable extent [6, 9] and thereby release nitrogen compounds.”

References [6, 9] cited therein were published on 1998 and 1971 respectively.

Lines 45-55 at column 1 of page 1 explain that the nitrogen-containing impurities have a major influence on the self-discharge of batteries containing an alkaline aqueous electrolyte.

Thus, the skilled person would not consider Vandayburg, since it concerns the technical field of lithium ion batteries which is remote from the field of alkaline aqueous batteries as specified in claim 1.

For all of the reasons discussed in detail above, it is submitted that the invention defined in the pending claims would not have resulted from any obvious combination of the cited art.

In view of the above, reconsideration and allowance of this application are now believed to be in order, and such actions are hereby solicited. If any points remain in issue which the Examiner feels may be best resolved through a personal or telephone interview, the Examiner is kindly requested to contact the undersigned at the telephone number listed below.

Respectfully submitted,

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